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ABSTRACT

In a climate of rapid change, increasing innovation, and proliferating knowledge, lifelong learning is an important educational objective. Lifelong learning skills need to be developed if educators intend for their students to stay current in their fields. Staying abreast of new innovations, research, techniques, and information is a prerequisite for successful decision-making and problem-solving on the job. This paper provides an overview of instructional methodologies--problem-based learning, intentional learning, reciprocal teaching, and cognitive apprenticeship--that prepare students for lifelong learning. Using collaboration, reflection, student autonomy, and intrinsically-motivating activities, these instructional methodologies help students develop the metacognitive and self-directed learning skills needed to remain competitive in an ever changing professional climate. (Contains 46 references.) (SWC)

Preparing Students for Lifelong Learning: A Review of Instructional Methodologies

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Statement of Problem

In a climate of rapid change, increasing innovation, and proliferating knowledge, lifelong learning is an important educational objective. In order to keep current in their fields, people have to be willing and able to continually "retool" their knowledge and skill base. The need to be a continuous learner is especially apparent in the domains of medicine, law, business, engineering, and information technology because of the overwhelming explosion of information and technological advances in those fields. Nash (1994) reports:

- More than 6,000 scientific journal articles are written every day;
- Scientific and technical information currently increases 13 percent a year which means that this information doubles every 5.5 years;
- The rate of increase will soon jump to 40 percent per year due to the increasingly powerful information systems and the increasing population of scientists; and
- These increases will cause the scientific database to double every 20 months.

Because of the exponential growth rate of information, knowledge and skills become obsolete before acquisition, let alone mastery, is possible. To effectively address the impact of the information explosion on the preparation of students for the future, professional schools and educators need to utilize instructional methodologies that not only help students acquire content knowledge and develop problem-solving and reasoning skills, but also develop lifelong learning skills.

Importance of Lifelong Learning

The knowledge explosion requires professionals to engage in lifelong learning if they intend to stay current — let alone evolve, advance, and remain competitive — in their profession. Therefore, lifelong- learning skill development is imperative if practitioners are expected to learn over the full expanse of their professional lives. Unfortunately, some of the practitioners that most need lifelong learning skills — those with careers in ill-structured, complex professions — are not developing them during their formal education. Regarding the lack of lifelong-learning skill development in schools, Walton and Matthews (1989, p. 551) state, "Some doctors from medical schools with the usual type of curriculum behave as if they had been immunized against further learning, and many doctors often do not continue to learn sufficiently." Supporting this, a study examining doctors' performance on a recertification examination over a number of years found that their performance on questions related to changes and innovations in their fields declined with each passing year; this decline was attributed to the doctors' inability to acquire new knowledge, not as a result of forgetting previously acquired knowledge (Day, Norcini, Webster, Viner, & Chirico, 1988).

"We teach most effectively when we help our students learn how to learn...not what to think and make and do in [the current year]; but how to think and how to learn for those years of life and profession than lie ahead" (Nash, 1994, p. 789). To achieve this requires moving away from a view of learning that is controlled outside the individual to a view of learning that is internally controlled by the individual (Overly, McQuigg, Silvernail, & Coppedge, 1980). Specifically, the ability to engage in lifelong learning is based on the development, and subsequent successful application, of two skill areas: metacognition and self-directedness.

Metacognition

Von Wright (1992, p. 64) defines metacognitive skills as "the steps that people take to regulate and modify the progress of their cognitive activity: to learn such skills is to acquire procedures which regulate cognitive processes." Glaser (1984) describes metacognitive or self-regulatory skills as knowing what one knows and does not know, predicting outcomes, planning ahead, efficiently apportioning time and cognitive resources, and monitoring one's efforts to solve a problem or learn. Metacognitive skills include taking conscious control of learning,

planning and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies when necessary (Ridley, Schultz, Glanz, & Weinstein, 1992). Because metacognition involves these self-regulatory skills, it can have a positive impact on problem solving ability and the transfer of knowledge across domains and tasks if developed during instruction (Bereiter & Scardamalia, 1985; Bransford, Sherwood, Vye, & Rieser, 1986). In fact, if not developed, students have difficulty recognizing when they have failed to adequately meet learning goals or complete tasks (Bransford et al., 1986). Since these are skills utilized by successful practitioners and experts (Chi, Feltovich, & Glaser, 1981; Bransford et al., 1986), adequately developed metacognitive ability is needed in order to engage in effective problem solving and reasoning activities.

Self-directedness

To be successful, students must develop the self directed learning skills needed [within the domain]. They must be able to develop strategies for identifying learning issues and locating, evaluating, and learning from resources relevant to that issue. (Savery & Duffy, 1995, p. 143)

When dealing with real patients, the doctor has to begin assessing the patient's condition before having all of the data necessary to evaluate, diagnose, and treat the patient. Characteristically, the patient provides the doctor with fragments of information ("My stomach hurts. I can't hold any food down. No one else in my family is experiencing any problems."). The rest of the information needed to solve the patient's problem comes from the study of a variety of other resources: patient and family history, laboratory results, x-rays, other doctors' opinions, past experiences, similar cases in the case file, and current research findings on new diagnostic and treatment procedures. The doctor has to determine what information is needed, what resource should be used to acquire the information needed, how to use the resource effectively, how to come to terms with opposing or contradictory information, and how to apply the information acquired to the problem to achieve a solution for the patient. These skills are described as "self-directed learning skills" (Barrows, 1985, 1986). Barrows (1995) defines the process of self-directed learning as utilizing the following skills to solve a problem or fulfill a learning requirement:

- the ability to identify and define a problem/ learning need;
- the ability to identify, find, use, and critique resources for solving the problem or meeting the learning requirement;
- the ability to capture and apply information from resources to the problem or learning need; and
- the ability to critique information, skills, and processes used to solve the problem or meet the learning requirement.

In summary, lifelong learning skills, specifically metacognitive and self-directed learning skills, need to be developed if educators intend for their students to stay current in their fields. Staying abreast of new innovations, research, techniques, and information is a prerequisite for successful decision-making and problem-solving on-the-job. There are a number of instructional methodologies that purport to nurture the development of lifelong learning skills by engaging students in authentic, problem-centered learning experiences in which they are responsible for making decisions across all phases of the activity. The next section summarizes four of those methodologies.

Instructional Methodologies that Develop Lifelong Learning Skills

This section examines four instructional methodologies that help students develop the metacognitive and self-directed learning skills needed to be lifelong learners. With common theoretical roots in cognitive psychology, these methodologies are: problem-based learning (PBL), intentional learning, reciprocal teaching, and cognitive apprenticeship. Using similar instructional strategies, these methodologies engage students in the types of cognitive activity needed to build knowledge, including lifelong learning skills, that students can transfer to new situations.

Problem-based Learning (PBL)

Problem-based learning (PBL) is an instructional methodology that uses an authentic problem, need, or challenge as a context for students to learn problem-solving and lifelong learning skills and acquire knowledge about a particular domain (Barrows & Tamblyn, 1980; Boud, 1985).

The basic outline of the problem-based learning process is: encountering the problem first, problem-solving with...reasoning skills and identifying learning needs in an interactive process, self study, applying newly gained knowledge to the problem, and summarizing what has been learned. (Barrows, 1985, p. 15)

In a PBL environment, students work with problems in a manner that fosters reasoning and knowledge application appropriate to their levels of learning. In the process of working on the problem and with their peers, students identify areas of learning to guide their own individualized study. The skills and knowledge acquired through individualized study are applied back to the problem to evaluate the effectiveness of learning and to reinforce learning. The learning that has occurred in work with the problem and in individualized study is summarized and integrated into the student's existing knowledge structure.

PBL Strategies for Lifelong Learning.

The development of lifelong learning skills is an important educational objective of problem-based learning (PBL). PBL works towards this objective during each phase of the PBL process. In phase 1 — referred to by Barrows (1985, p. 62) as "reasoning through the problem and identifying educational needs in counterpoint" — students reason aloud through the presented problem, defining what they know and do not know, formulating hypotheses, clarifying understanding through negotiation, critiquing peers' comments about the problem, and setting educational goals and creating action plans to meet those goals. With tutor coaching and scaffolding, these activities help students develop the self-monitoring skills necessary to identify learning needs by making their internal thinking processes overt. The development of self-monitoring skills is an important part of being metacognitive and, therefore, contributes to students' ability to be lifelong learners.

During the self-directed study phase — phase 2 — of a PBL activity, students carry out their action plans by engaging in self-study. Students determine how long it will take to address an action plan item, create a timeline, and determine the required resources. This process helps students develop self-directed learning skills which is a critical component of lifelong learning.

During phase 3, when students apply the information acquired during self-study to the problem, students critique the resources used during self-study as well as their personal research methods. By critiquing the resources and their research methods, students acquire insight as to what resources were helpful and why, what research methods were productive and why, and what resources and methods did not work, why, and how they can be improved for the future. Constant assessment of information sources and personal processes is critical for lifelong learning.

The final phase — summary and integration of learning — is an important phase in PBL; if phase 4 is skipped or cut short, then the full impact of students' PBL experience is lost. During this phase, students summarize what they have learned and discuss how it will be used during future problems. Students consciously recall and reflect on the learning that occurred while they were solving the problem, elaborate on that learning, and integrate it into their existing knowledge structures (Barrows, 1985). Because it focuses students' attention on their learning processes, this activity further builds the metacognitive skills needed for lifelong learning.

According to Barrows (1985), this educational cycle develops students' lifelong learning skills. The PBL process engages students in activities that (1) make their thinking processes overt so they can monitor and assess the effectiveness of their problem analysis, reasoning skills, and knowledge acquisition decisions and processes and (2) encourage and enable them to assume more and more responsibility for their own instruction and learning (Barrows, 1985; Bridges, 1992).

Intentional Learning

Intentional learning is learning that is actively pursued by and controlled by the learner (Resnick, 1989). Palincsar and Klenk (1992) describe intentional learning as an achievement resulting from the learner's purposeful, effortful, self-regulated, and active engagement. It refers to the "cognitive processes that have learning as a goal rather than an incidental outcome" (Bereiter & Scardamalia, 1989, p. 363). According to Bereiter and Scardamalia (1989), conventional classroom instruction treats learning as an activity rather than a goal. Although learning occurs, it is not the higher-order learning needed for students to really understand what they have learned so they can apply it in the future.

By encouraging students to take "an intentional stance toward cognition" (Scardamalia & Bereiter, 1991, p. 37), intentional learning helps students learn how to not only monitor and be aware of their own thinking and

learning processes (i.e., metacognitive skills), but also to take responsibility for pursuing individually-determined learning goals (i.e., self-directed learning) (Brown & Palincsar, 1989).

Intentional Learning Strategies for Lifelong Learning.

The objective of an intentional learning environment is to create a supportive structure in which students can engage in cooperative knowledge building as they move towards greater autonomy. Addressing students' need for higher-order abilities in thinking and learning, intentional learning helps students develop the general metacognitive and self-directed learning skills that facilitate autonomous lifelong learning (Palincsar, 1990; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989), specifically the ability to:

- monitor and assess how they learn, think, and solve problems, and make adjustments when necessary;
- make maximum use of existing knowledge;
- ask questions to identify knowledge deficits and set personal learning goals to address those deficits in positive ways;
- utilize learning strategies other than rehearsal to attain learning goals;
- access, apply, and evaluate appropriate resources, including peers and teachers; and
- manage the learning process (set goals, create action plans, set deadlines, identify appropriate learning strategies).

These skills are developed by engaging students in situations in which they need to build a body of knowledge based on their learning interests and needs using a variety of information resources. While building the knowledge base, students practice tactics for making claims, collecting evidence in support of their claims, and evaluating and responding to counterarguments from peers and teachers. Through this knowledge-building process, students reflect on specific aspects of their learning and thinking processes, and consider the effects of collaboration on each other's learning, such as the impact of opinion, bias, controversy, debate, and negotiation (Glaser, 1991).
In addition, intentional learning prepares students for self-directed learning activities by helping them learn how to ask questions based on personal knowledge deficits and formulate learning goals to address those deficits. Research by Scardamalia and Bereiter (1991) indicates that students can learn to ask questions to guide their knowledge building, thus assuming more control and ownership over their learning activities. Because intentional learning emphasizes question generation to guide goal attainment, students acquire ownership over learning activities, find personal relevance during learning activities, and develop skills needed to be lifelong learners.
In summary, an intentional learning environment helps students to be more intentional, and therefore more metacognitive and self-directed, by utilizing instructional tactics that promote student autonomy.

Reciprocal Teaching

Reciprocal teaching is a teacher-led, cooperative learning methodology developed to improve students' understanding of complex text (Brown & Palincsar, 1989; Palincsar & Brown, 1984). Reciprocal teaching provides a collaborative support structure "within which novices could take on greater responsibility for more expert roles" (Brown & Palincsar, 1989). Palincsar and Klenk (1992, p. 213) describe reciprocal teaching as:

> ...an instructional procedure that takes place in a collaborative learning group and features guided practice in the flexible application of four concrete strategies to the task of text comprehension: questioning, summarizing, clarifying, and predicting. The teacher and group of students take turns leading discussions regarding the content of the text they are jointly attempting to understand.

Reciprocal teaching helps students develop the comprehension-monitoring and comprehension-fostering skills (i.e., metacognitive skills) needed to improve reading comprehension (Slavin, 1994). Teachers model reading comprehension skills and students practice these skills during cooperative discussions that focus the student's attention on understanding both (1) the text's content and (2) the reading comprehension strategies being practicing.

Reciprocal Teaching Strategies for Lifelong Learning.

In a reciprocal teaching environment the teacher models learning strategies in a problem context that is shared directly and immediately with students. This makes explicit the cognitive processes that have to occur in

order to comprehend text; the modeling process decomposes the reading comprehension task so students can see how the strategies work and how to go about applying the strategies themselves (Collins, Brown, & Holum, 1991). The teacher's modeling of reading comprehension skills encourages students to focus their attention on their observations of the teacher and then to reflect on their own performance as compared to the teacher's performance (Collins, Brown, & Newman, 1989).

The reciprocal teaching process begins with the class reading an excerpt from a text. After the excerpt is read, the teacher demonstrates the reading comprehension skills by articulating the questions that need to be asked about the excerpt in order to clarify understanding, summarizing the text, making predictions about what will happen next in the text, and discussing what parts of the excerpt were personally problematic. During this phase, students listen to the teacher in the context of knowing that they will have to undertake the same task. This focuses their attention on how the teacher's activities relate to the excerpt.

Then, with the teacher scaffolding student performance, each student takes on the role of the teacher for a new text excerpt, modeling the reading comprehension strategies for peers the same way the teacher did and guiding the direction of the group's discussion. Throughout, other students respond to the questions, raise their own questions, and, in cases of disagreement or confusion, reread the text.

Because these activities take place in a collaborative environment, immediate feedback is provided by peers and the teacher, helping students to (1) clarify their understanding of the text and (2) effectively utilize the reading comprehension strategies.

The collaborative structure also helps students form a new conceptual model of the task of reading. By articulating their understanding and critiquing others' understanding, students experience reading as a process that involves reflection and prediction rather than just the recitation of words. They learn to relate what they are reading to their needs, monitor their progress, and strive for understanding. This process of reflection and articulation within a collaborative group structure makes students' thinking observable, enabling students to analyze, critique, understand, and improve their reading comprehension strategies (Glaser, 1991). This kind of self-awareness is critical to lifelong learning activities (Collins & Brown, 1988).

In summary, with reciprocal teaching students generate their own learning goals, do their own activating of prior knowledge, ask their own questions, direct their own learning activity, and do their own comprehension monitoring (Brown & Palincsar, 1989; Palincsar & Brown, 1984). By teaching students how to flexibly apply the metacognitive and self-directed learning strategies of questioning, summarizing, clarifying, and predicting, reciprocal teaching develops skills integral to lifelong learning.

Cognitive Apprenticeship

Cognitive apprenticeship is an instructional methodology that supports the acquisition, development, and use of domain-specific cognitive tools by engaging students in authentic domain activities (Brown & Palincsar, 1989). Modeled after the traditional apprenticeship way of learning arts and crafts, cognitive apprenticeship makes the usually invisible cognitive processes of an activity visible so they can be observed, practiced, and mastered with help from the teacher and other students (Collins et al., 1989). In order to address the problems of inert knowledge, learning activities are embedded in a variety of authentic contexts, creating "a rich web of memorable associations between them [concepts and facts] and problem-solving concepts" (Collins et al., 1989, p. 457). Cognitive apprenticeship focuses on "the learning-through-guided-experience [of] cognitive and metacognitive, rather than physical, skills and processes" (Collins et al., 1989, p. 457).

Cognitive apprenticeship teaches students the processes that experts use when addressing complex tasks within a professional domain. To this end, cognitive apprenticeship activities create a learning environment in which students not only acquire the conceptual and factual knowledge of a domain, but also the problem-solving strategies and heuristics, control strategies (metacognitive skills), and learning strategies (self-directed learning skills) of the domain (Collins et al., 1989). Therefore, just as the format of traditional apprenticeship helps an apprentice learn how to use the tools of the trade, cognitive apprenticeship helps students learn how to use the cognitive tools required for lifelong learning by enabling students to acquire, develop, and use cognitive and metacognitive tools as they engage in authentic domain activity (Brown & Palincsar, 1989).

Cognitive Apprenticeship Strategies for Lifelong Learning

To help students develop metacognitive and self-directed learning skills, cognitive apprenticeship employs: modeling, coaching, scaffolding and fading, articulation, reflection, and exploration (Collins et al., 1989; Collins et

al., 1991). The first three strategies — modeling, coaching, and scaffolding/fading — help students develop cognitive and metacognitive skills via observation and guided, supported practice. Articulation and reflection help students focus on their problem solving processes through elaborative activity in order to acquire conscious access to and control over their own metacognitive and self-directed learning processes and strategies (Collins et al., 1989).

Exploration encourages learner responsibility and autonomy in solving problems.

In a cognitive apprenticeship environment, these six instructional strategies make cognitive processes that are normally invisible visible, just as in a traditional apprenticeship a tailor makes sewing processes visible to an apprentice. For example, a teacher may first model a cognitive task by thinking aloud while performing it, making the thinking processes visible to students. Then the teacher watches, coaches, and provides feedback and support as students practice portions of the task. As students demonstrate their ability to complete tasks on their own, the teacher gradually removes supports, turning over more and more responsibility for the learning process to students.

Cognitive apprenticeship also encourages students to articulate and reflect on activities so they can elaborate on the learning that has occurred during the modeling-coaching-scaffolding/fading cycle. For the same reasons the review phase is used in PBL, articulation and reflection activities make tacit cognitive activities overt and observable so students can assess what they have learned, what worked and did not work, and what they will do differently in the future.

Finally, when supports have been faded and students are able to monitor and assess their own learning and thinking processes, exploration is possible. Students need to engage in exploratory activities to learn how to engage in problem-solving activities, from start to finish, on their own (Collins et al., 1989). In other words, learning how to engage in exploration enables students to be self-directed learners.

Throughout this process, cognitive apprenticeship helps students develop the skills needed to be autonomous learners by engaging them in the activities of the authentic domain: the domain in which the skills and knowledge they are learning is applied. Part of the authentic domain that cognitive apprenticeship activities reflect is the social context in which learning occurs. "Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge" (Brown & Palincsar, 1989, p. 40). In a cognitive apprenticeship environment, collaboration provides students with an additional source of scaffolding during learning and problem-solving activities. Collaborative learning and problem-solving requires students to share their knowledge and skills, giving them additional opportunities to clarify understanding and assess overall processes; sharing knowledge and skills with others fosters the situated articulation of processes and concepts, helping students acquire conscious access to and control of cognitive and metacognitive processes (Collins et al., 1989).

Commonalties Across Methodologies

The instructional methodologies described in the preceding section create knowledge-building communities that help students develop lifelong learning skills. Interestingly, these methodologies employ similar instructional strategies to prepare students for lifelong learning, specifically:

- collaboration,
- reflection,
- student autonomy activities, and
- intrinsically motivating activities.

This section summarizes how these methodologies use these strategies to fulfill the lifelong learning objective.

Collaboration

Instructional methodologies focusing on the development of lifelong learning skills employ collaboration to promote thinking because collaborative activities engage students in an interactive approach to learning (Johnson & Johnson, 1986). The methodologies described in this paper recognize the importance of collaboration, social cognition, and the social context of learning. The social context — manifested in collaborative group activities — elevates thinking, learning, and problem-solving to an observable status (Glaser, 1991), making students' metacognitive processes apparent. This provides students with opportunities for understanding and sharing these processes — refining, strengthening, and extending their metacognitive skills (Von Wright, 1992).

Collaboration and using peers as resources plays an important role in *problem-based learning*. First, PBL employs collaboration to provide students with opportunities to see and hear how other students approach and solve

problems. Because the students in a collaborative group are working closely together, students are able to share ideas and perspectives, as well as help each other clarify issues. This is important in helping students develop metacognitive skills.

Second, PBL problems are complex because they are authentic. Students may not be used to or able to tackle a realistic problem on their own. Students working together collaboratively can often successfully tackle problems that individual students working alone would not be able to handle; collaborative learning can "give rise synergistically to insights and solutions that would not come about without them [the members of the collaborative group]" (Brown & Palincsar, 1989, p. 40).

Finally, PBL encourages articulation through collaboration. During the problem analysis phase of PBL, students describe what they know and do not know about a problem and what they need to learn. When preparing for self-study, students determine how long it will take to fulfill a learning goal, what strategies they will employ, and what resources they will access. Being able to determine learning needs and plan a method of attack are important metacognitive skills for lifelong learners. Because students are working collaboratively during problem solving, their thinking processes — or metacognitive skills — are observable and therefore open for personal and peer assessment and refinement. Accordingly, collaboration provides students with a support structure while they develop the metacognitive skills needed to be lifelong learners.

In *intentional learning* environments, students develop higher-order thinking skills by working together to build knowledge bases. Collaborative knowledge building requires that students articulate what they have learned, what questions are left unanswered, and their plans for future learning. These activities force students to think metacognitively. Also, because students are pursuing individual learning goals, the collaborative structure provides students with guidance and coaching, through collaborative critiquing, while they are acquiring self-directed learning skills. Therefore, within an intentional learning environment, collaboration is used to provide support for students as they develop the skills needed to be lifelong learners.

The group discussion aspect of a *reciprocal teaching* activity is like the group problem analysis phase in a PBL activity. During group discussion, students review content (summarize), attempt to resolve misunderstandings (clarify), anticipate possible future text development (predict), and assess what they have learned from the text (question). These activities encourage students to articulate and bring into the open the internal dialogue that experienced students engage in to foster comprehension. The reciprocal teaching procedure helps students learn how to engage in that internal dialogue by making them think aloud. Because students are thinking aloud, peers and teachers can provide guidance and support until the reading comprehension strategies are incorporated into students' repertoire of learning strategies (Brown & Palincsar, 1989). Reliance on collaboration in reciprocal teaching is critical to the development of the metacognitive skills needed to learn from expository text — the same metacognitive skills needed to engage in lifelong learning activities.

In a *cognitive apprenticeship* environment, collaboration provides additional scaffolding while students learn cognitive and metacognitive skills (Collins et al., 1989). Because students share knowledge during collaboration, they must articulate what they know. If misunderstanding occurs, students clarify points and assess their overall understanding. This forces students to develop metacognitive awareness, a key component of the lifelong learning construct. Students involved in cognitive apprenticeship activities develop critical metacognitive skills that will enable them to perform as lifelong learners.

Reflection

These instructional methodologies also encourage students to review and reflect on what they have learned and how they have learned. Self-reflection activities are embedded into instructional activities to support the development of metacognitive skills. "Self-reflection implies observing and putting an interpretation on one's own actions, for instance, considering one's own intentions and motives as objects of thought" (Von Wright, 1992, p. 61). Von Wright describes the process of self-reflection as the ability to think about one's self as an intentional subject of personal actions and to consider the consequences and efficacy of those actions. This involves the ability to look at one's self in an objective way and to consider ways of changing to improve performance.

Reflective skills play an important role in the development of metacognitive skills. Dewey (1933) described the value of reflection as a component of educated thinking. Contemporary researchers have further elaborated on this argument by describing the relationships between reflection, metacognitive skills, and the development of problem-solving strategies (e.g., Kuhn, 1989). The specific contribution of reflection in the

development of metacognitive skills is its role in consolidating the development of new strategies and encouraging transfer (Schauble, Raghavan, & Glaser, 1993).

Even though reflective activity is important, it is possible for students to be so caught up in completing a task that they fail to reflect, hindering what they learn. "We can keep students so busy that they rarely have time to think about what they are doing, and they may fail to become aware of their methods and options" (Wheatley, 1992, p. 536). Schön (1983) refers to this as being "in the action" rather than reflecting on the action. If students do not have opportunities to examine their methods and options, they will not develop the metacognitive skills needed for lifelong learning. Therefore, teachers need to support students in reflecting on their own learning and problem-solving processes, as well as on what they have learned (Schön, 1987).

Blakely and Spence (1990) describe several basic reflective strategies that need to be employed by an instructional methodology to develop metacognitive skills:

- Students should be asked to consciously identify what they "know" as opposed to "what they don't know".
- Students should keep journals or logs in which they reflect upon their learning processes, thinking about what works and what does not.
- Students should manage their own time and resources including estimating time requirements, organizing materials, and scheduling the procedures necessary to complete an activity.
- Students should engage in guided self-evaluation through individual conferences and checklists to help them focus on the thinking process.

Blakely and Spence's strategies illustrate the importance of student reflection in promoting the development of metacognitive skills.

Reflective activities, as defined by Blakely and Spence, are a common characteristic of the instructional methodologies described in this paper. A common goal of these methodologies is to induce students to include self-reflection as an essential component of their action strategies in the context of learning and problem-solving (Boud, Keogh, & Walker, 1985; Harris, 1989; Von Wright, 1992).

In a *problem-based learning* environment, reflection occurs during the review phase. During this phase, students assess the effectiveness of their learning strategies and accomplishments. They critique the resources used, reexamine points of agreement and disagreement, clarify comprehension problems, and determine what they would do differently in the future to improve on their own personal learning process. The ability to reflect on personal learning strategies and processes is necessary for enhancing metacognitive ability, and preparing for new learning issues and challenges.

In an *intentional learning* environment, the importance of students' awareness of the functional potential of knowledge for the acquisition of other knowledge is emphasized (Bereiter & Scardamalia, 1989). According to Bereiter and Scardamalia, of equal importance to becoming an intentional learner is the awareness of the potential of self-reflection as a tool for engaging in intentional learning activities. Understanding the functional potential of knowledge for the acquisition of new knowledge is critical to lifelong learning. Part of being metacognitive, students must learn to use what they have learned — in terms of content and skills, as well as personal learning strategies and processes — to improve subsequent learning activities and further future learning endeavors.

Besides providing social support, shared expertise, and role models, *reciprocal teaching* also stimulates self-reflection. In fact, central to the reciprocal teaching methodology is the emphasis on social interaction as a condition for developing students' reflective skills (Brown & Palincsar, 1989). Reflective skills come into play when students take on the role of teacher and lead group discussions. When leading the group discussion, it is necessary for the student to decide what has to be explained or taught based on the group's conceptions and misconceptions. In addition, the student has to assess how one's teaching is impacting the group's conceptions and misconceptions. Trying to understand another person's perspective on an excerpt of text, a requirement for participation in a reciprocal teaching activity, forces students to reflect on their own perspectives.

In a *cognitive apprenticeship* environment, reflection is encouraged so students will elaborate on what they have learned. Again, as in the review phase of *PBL*, reflection activities make tacit cognitive and metacognitive activities overt so students can assess and improve them. Having opportunities to reflect on metacognitive skill utilization is necessary if students are expected to develop these skills to the point of using them without prompting or guidance. Reflection enables students to assess and improve their skill use to affect a change in subsequent utilization practice; without reflective activities students may never change their utilization patterns, regardless of

effectiveness. Therefore, reflective activities help students assess how they are learning and improve their strategies and processes, preparing them to independently utilize appropriate metacognitive skills during lifelong learning activities.

Student Autonomy

All of these methodologies engage students in activities that gradually increase their control and responsibility over the learning process. Creating autonomous learners, these methodologies teach students how to plan their learning: how to address their learning needs, set learning objectives, employ learning strategies, utilize resources, and assess the overall process. In other words, these methodologies help students acquire more agency over their zones of proximal development. For the most part, this is done through guided social interaction.

The tutor in a *problem-based learning* environment provides a supportive structure while students learn to direct their own learning. When students are stuck and can go no further on a problem, the tutor asks questions that help students refocus on the problem, enabling them to proceed. Another source of assistance is keeping a record of the group's progress on the chalkboard. This activity, started during PBL's problem analysis phase and updated throughout the other phases, is a method of externalizing thinking processes and helps students remember and organize their thoughts.

In an *intentional learning* environment, students are required to build their own knowledge bases founded on personal learning needs and interests. To do this, students must take responsibility for managing the learning process. This includes setting goals, creating action plans, setting deadlines, and identifying appropriate learning strategies. Even though students are required to manage their own learning, they are supported by peers and teachers who help them move towards autonomy. A PBL environment is very similar. During phase 1 of a PBL activity, students identify knowledge deficits, set learning goals based on those deficits, and create action plans to fulfill those learning goals. During the self-study phase, students determine what resources they will use to address their action plan. These decisions are all made by the students. Although students are supported by each other and their teacher, they are responsible for managing the learning process, helping them achieve greater student autonomy over learning activities.

The modeling, coaching, and scaffolding/fading process employed by *reciprocal teaching* and *cognitive apprenticeship* provides assistance so students can accomplish a task they would not be able to carry out without help (Vygotsky, 1978). Modeling is the demonstration of the problem-solving process. Through modeling, students obtain a complete mental picture of the process they are learning because the cognitive and metacognitive processes are explicit. Coaching provides students with guidance while they practice solving problems. As students begin to solve problems on their own, the supportive structure is slowly faded until it can be completely removed. This process helps students develop metacognitive awareness while preparing them to be self-directed and lifelong learners.

Intrinsically-Motivating Activities

For students to be oriented toward lifelong learning, they must be willing to continue to learn. This willingness to learn is a product of intrinsic and continuing motivation (Kinzie, 1990). Intrinsic motivation is the desire to pursue a goal in which the primary reward is the pursuit itself. When students are intrinsically motivated, they are more likely to be more self-determined; they may attempt more problems, focusing on the way to solve the problem instead of on finding the correct solution (Condry & Chambers, 1978). The self-determination and desire to return to a learning activity is part of lifelong learning. Therefore, motivation to engage in lifelong learning activities may have an impact on students' determination and desire to engage in lifelong learning in the future.

The instructional methodologies described in this paper employ intrinsic motivation strategies to get students excited about learning. Intrinsic motivation strategies are based on the idea that students will expend more effort on tasks and activities they find inherently enjoyable and interesting, even when there are no extrinsic incentives (Keller & Burkman, 1993). The instructional methodologies described in this paper employ the following tactics to encourage and sustain intrinsic motivation:

- Students are actively engaged in leading, recording, discussing, facilitating, making decisions, collaborating, making presentations, and evaluating throughout the learning activity.

- Students fulfill higher-level objectives and answer divergent questions. At the heart of each learning activity is a problem to be solved. Solving the problem involves analyzing the situation presented, applying existing and new knowledge, evaluating alternative solutions, forecasting consequences, and assessing the problem solving process.

- Students take ownership of the problem by assuming the roles of real stakeholders. When students take on the roles of scientists, programmers, historians, etc., their "motivation soars because [they] realize it's their problem" (Stepien & Gallagher, 1993).

- Students engage in authentic activity. The advantage of engaging students in authentic problem-solving activities is that students become much more aware of how the knowledge they are acquiring can be put to use, improving their ability to transfer their knowledge and skills to future problems. "Adopting a problem-solving mentality...reinforces the notion that the knowledge is useful for achieving particular goals. Students are not being asked to store information away; they see how it works in certain situations..." (Prawat, 1989, p. 18)

Because intrinsic motivation impacts continuing motivation to learn, involving students in activities that make them excited about learning is critical not only for the success of the learning activity itself, but also to the development of students' commitment to learning throughout their lives.

Conclusion

This paper provided an overview of instructional methodologies — problem-based learning, intentional learning, reciprocal teaching, and cognitive apprenticeship — that prepare students for lifelong learning. Using collaboration, reflection, student autonomy, and intrinsically-motivating activities, these instructional methodologies help students develop the metacognitive and self-directed learning skills needed to remain competitive in an ever-changing professional climate.

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